SOSS User Guide

Document Change Log

Date	Version	Change Description	Author	Reviewer
10/06/2011	Initial		Zhifan Zhu	
11/9/2011	2nd	Added descriptions for new features of violation	Zhifan Zhu	
11/23/2011	3rd	Added description of data validation tool and FCFS	Zhifan Zhu	
12/27/2011	4th	Added Post Analysis Description	Sergei Gridnev	
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3/14/2014		Updated CAI 1.9 support	Sergei Gridnev	
11/10/2014		Updated/Added Aircraft List, Dynamic Scenario Input, Simulation Configuration, Uncertainty Configuration, Critical Area Control, Dynamic Scenario Input	Sergei Gridnev	

Table of Contents

1 Introduction

This User Guide describes SOSS software build and graphic user interface.

SOSS is a desktop application that simulates airport surface operations in fast time using traffic management algorithms. It moves aircraft on the airport surface based on information provided by scheduling algorithm prototypes, monitors separation violation and scheduling conformance, and produces scheduling algorithm performance data.

The diagram in Figure 1 shows the SOSS operation environment.

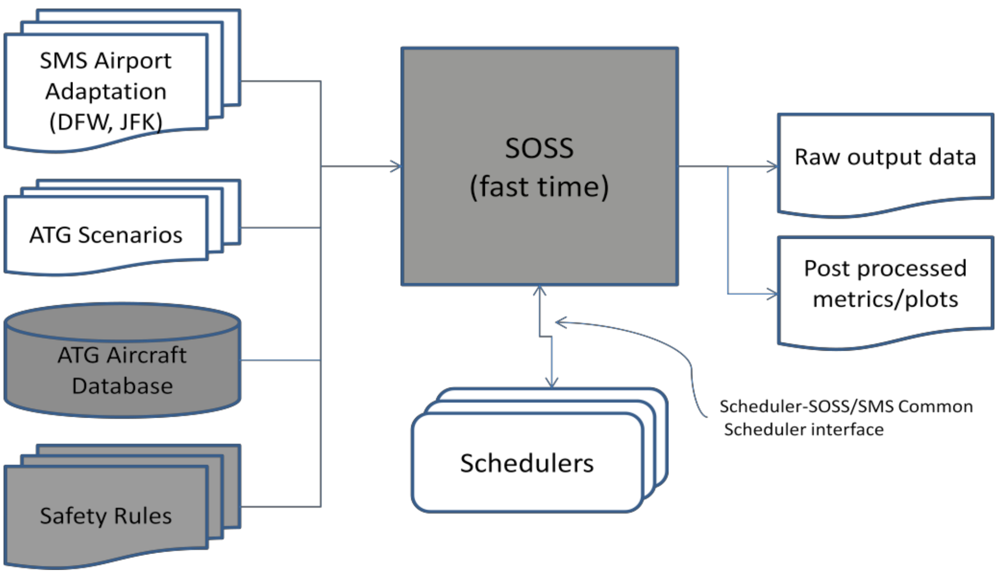


Figure 1

1.1 Platform OS

SOSS has been developed in cross-platform code. But at this release time, it has been built and tested only on Linux and Mac platforms.

1.2 Software Dependency

Two open-source software packages are required to build and run SOSS. They must be installed before building SOSS:

- Boost c++ library www.boost.org (version 1.47 or 1.48)
- Qt 4 library (version 4.6 and above)

1.3 Build

1.3.1 The software provides build scripts using cmake as following steps

- Copy the source code trunk to your system (e.g., /your_home/soss_source)
- Create a directory where you want to install the software, e.g., /your_home/soss.
- In the installation directory, type ‘ cmake /your_home/soss_source’
- If cmake goes through successfully, type ‘make’ to build

Note: the BOOST_ROOT variable at top level CMakeLists.txt is set default as /usr/local/boost to reflect the Boost installation at our development environment. It need be changed if your Boost is not installed at /usr/local/boost. Setting this variable is due to Boost’s the known Boost cmake script issue.

Successful build will create the binaries in bin directory:

- libSOSSAlgorithms – some internal algorithms that SOSS uses
- libSOSSEngine – the main SOSS engine
- soss – a command-line application that uses SOSS engine
- sossGUI – a GUI application to run SOSS engine
- dataValidate – a command-line tool to check soss input data

1.4 Run

SOSS executable can be launched from the bin directory from your installation location. See the GUI user guide section for sossGUI and command-line section for soss.

1.5 Data Directory

The data directory consists of airport adaptations, scenario data, and aircraft type database files that SOSS need. User can add additional airport adaptations and traffic scenarios late. The diagram in Figure 2 shows an example of data structure with two airports, DFW and JFK.

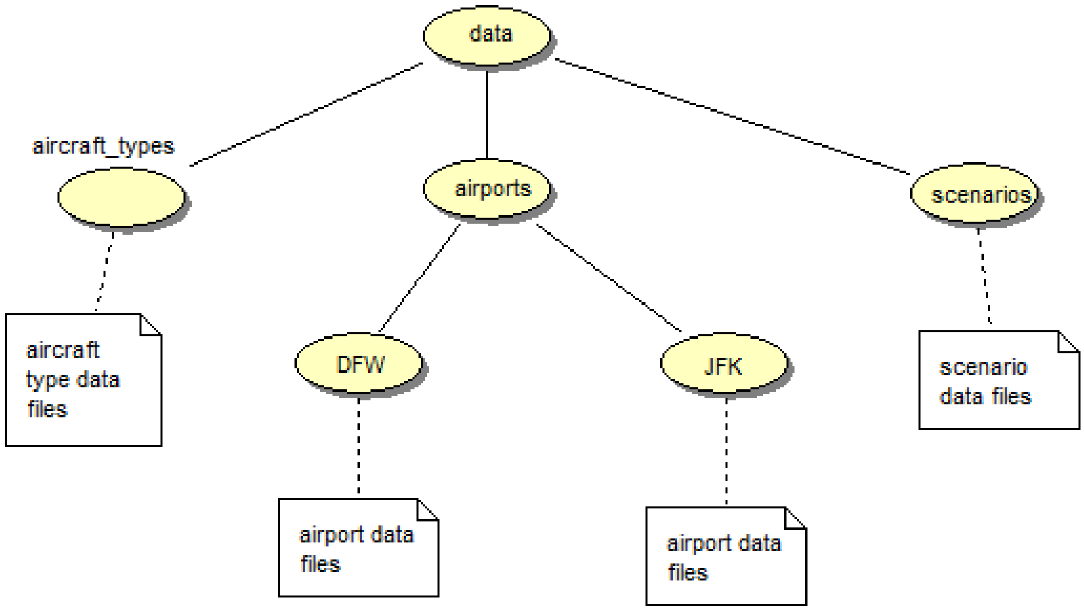


Figure 2

1.5.1 Airport Adaptations

The airport models are under each sub-directory of its name, e.g., DFW and JFK. The airport model data include:

- nodes.txt – node data
- links.txt – link data
- fixes.txt – fix data
- runways.txt – runway data
- runwayConfiguraitons.txt – runway configuration data
- separations.txt – separation rules
- routes.txt – a lookup-table like static taxi route data
- airport.txt – airport data
- CriticalArea.txt – defines exclusive areas for another level of ac-to-ac separation on runways (optional)

Separation rules consist of matrices for different runway operations. Rules are airport configuration dependent.

1.5.2 Traffic Scenario Data

Traffic data are given in scenario data files under data/scenario_data. User should not make changes to the file contents. New scenario data files can be brought in when needed.

Note that scenario data file embeds airport name and runway configuration information. User should not change the embedded information in scenario data file.

1.5.3 Aircraft Types

There are two data files under this directory, named *aircraft_types_data* and *initial_aircraft_model_properties*, respectively. They provide aircraft characteristics based on aircraft types. SOSS uses the information to model aircraft mobility. They should not be changed.

2 SOSS GUI

SOSS GUI allows a user to run SOSS interactively. It provides graphic interface controls and visualization of SOSS simulation run.

2.1 Main Window

To launch SOSS GUI application, type command ./sossGUI in bin directory. It will bring up the SOSS GUI window shown in Figure 3.

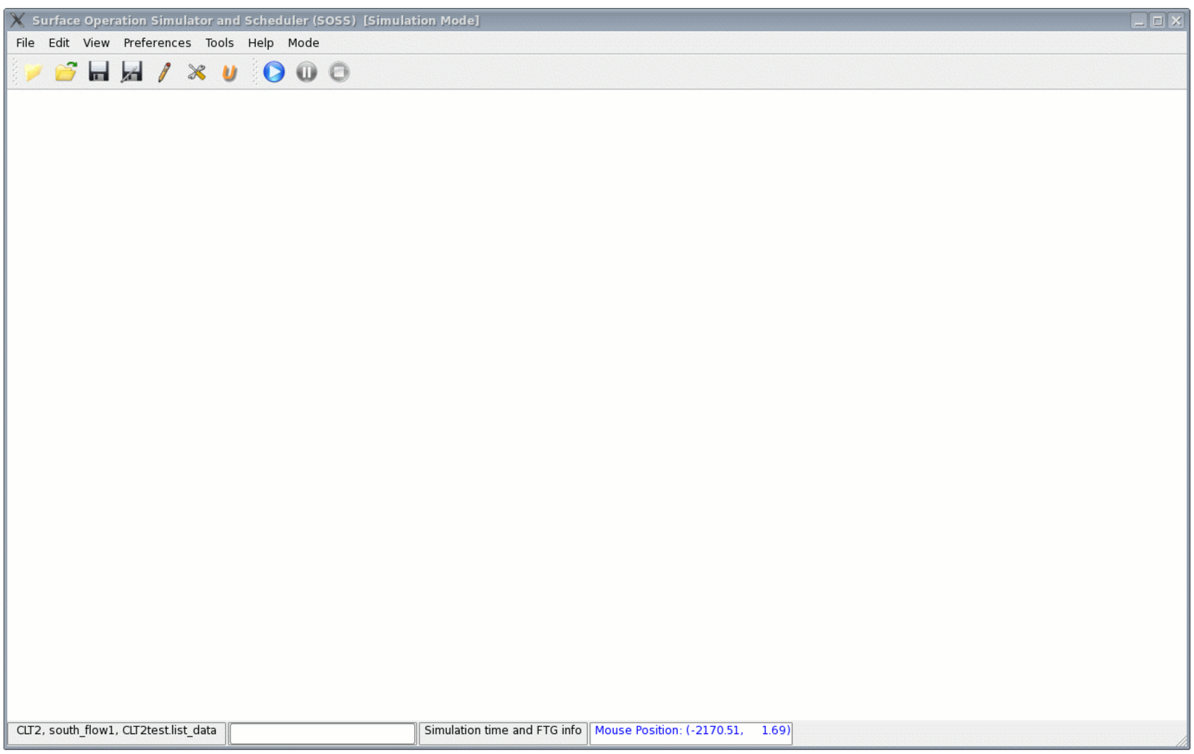


Figure 3

The SOSS GUI window consists of a main function menu bar, a short cut tool bar, a simulation status progress bar at the bottom, and an airport map display area in the center. Depending on the mode selected the tool bar options and the progress bar will vary in functions and appearance.

The main function menu bar includes seven menus.

2.1.1 File

The commands in this menu allow the user to choose an airport to preview or choose a scenario to run a simulation. In addition there are commands to save the SOSS configuration, post simulation data, and database to a file.

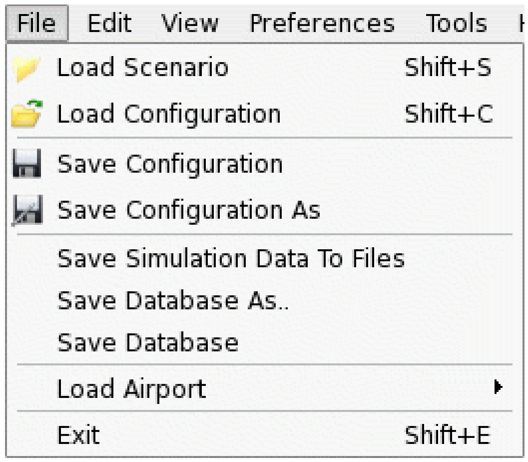


Figure 4

2.1.2 Edit

Commands in this menu allow the user to configure scheduler, runtime parameters, uncertainty generators, and traffic management control parameters that determine how a SOSS simulation will be run.

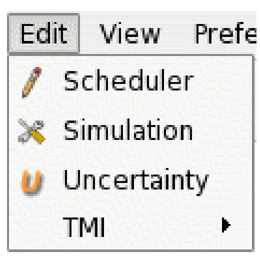


Figure 5

2.1.3 View

The View menu contains commands to show aircraft list and toggles to turn on and off some display options.

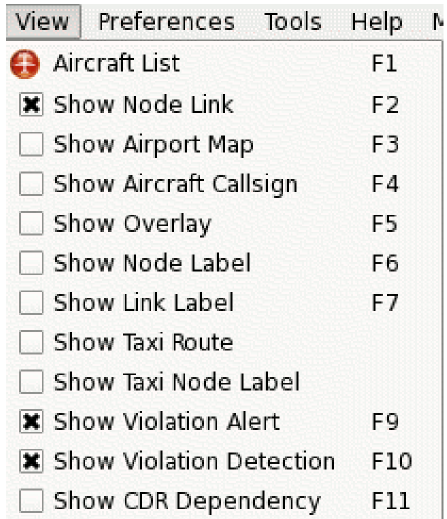


Figure 6

2.1.4 Preferences

The Preferences menu allows user to change colors in the map display.

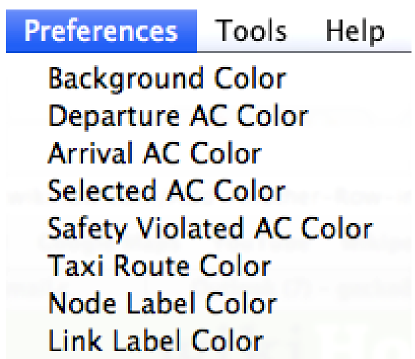


Figure 7

2.1.5 Tools

The Tools menu groups the functionalities for details of the simulation. Currently, Show Delays and Show Scheduler Call History tools have not been implemented yet.

Safety violations shown only contain separation violation between two AC on taxiway.

Figure 8

2.1.6 Help

The Help menu has two options: 1) search SOSS help topics., and 2) show the color legend of nodes and links.

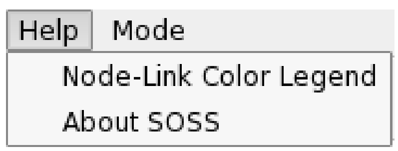


Figure 9

2.1.7 Mode

The Mode menu allows the user to select and check the current SOSS mode (Simulation or Playback).

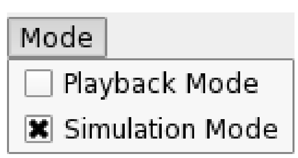


Figure 10

2.1.8 Status

At the bottom of the main window is the status bar. It consists of the following information:

- Airport and scenario data file
- Simulation progress in percentage of aircraft completion

- Current simulation time in seconds
- Map position (x,y) of the mouse pointer

2.2 Airport Preview

Choose ***File | Load Airport*** and choose one airport to preview its model.

2.3 Scenario File

Choose a scenario file from ***File | Load Scenario*** to load the traffic scenario. It will load corresponding airport model.

Traffic scenario data is the primary input data for simulation. This is the first step to start to simulate a new traffic scenario. The general procedure to run a SOSS simulation without configuration data file with GUI is:

- Select scenario data
- Configure scheduler and simulation parameters
- Start run simulation
- Analyze results

User can save the configuration parameters to a configuration file to avoid setting up those parameters repeatedly.

Once a scenario data is loaded, SOSS provides a default set of configuration parameters. After user's modification, the parameters can be saved by using ***File | Save Configuration as*** command.

2.4 Configuration File

Configuration file allow loading previously saved configuration to SOSS. Since scenario data file is part of the configuration, loading through a configuration data file will load the scenario data and airport at the same time.

- Choose ***File | Load Configuration*** and select a previously saved configuration file from the file dialogue.
- Choose ***File | Save Configuration*** or click on the short cut Save button in the tool bar to save configuration changes..
- Choose ***File | Save Configuration as*** or clicking on the short cut save as button in the tool bar to save configuration changes to a new file.

2.5 Configure Scheduler

Choose ***Edit | Scheduler or its tool button*** to open a dialog window to configure scheduler(s).

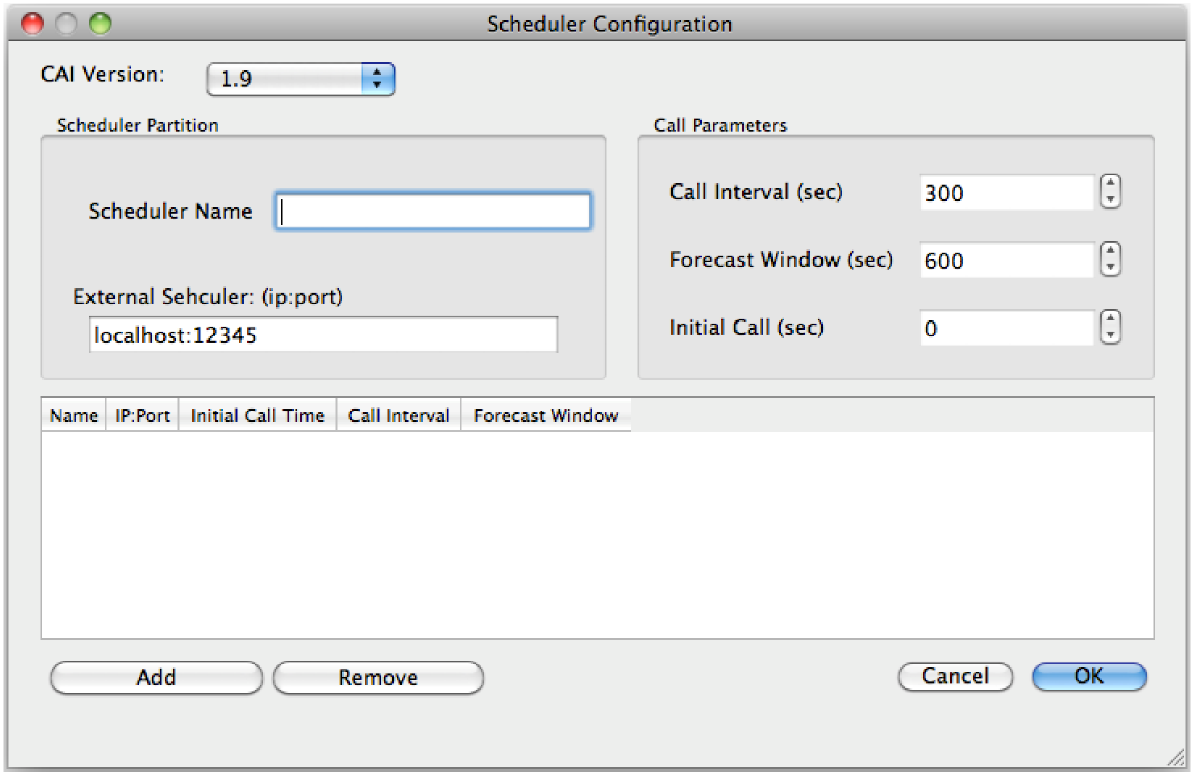


Figure 11

To provide interaction with various versions of Schedulers CAI Version drop box allows selection of the communication format that will be used for this particular run.

A scheduler configuration consists of following parameters:

- Scheduler Name – a name for the scheduler
- Scheduler address – this is the IP address and port number
- Call Intervals in seconds – this defines how often the scheduler is called
- Forecast Window in minutes – this is the window size that SOSS use to send aircraft information to scheduler for scheduling. E.g., a 10 minutes window will send those aircraft that is on surface and will be on surface within the window to scheduler
- Initial Call – this is the time that the scheduler will be called first time

At the bottom of the dialog shows the schedulers. User can add a new scheduler and remove a scheduler.

2.6 Simulation Controls

Choose ***Edit | Simulation or its tool button*** to open the dialog for simulation parameters.

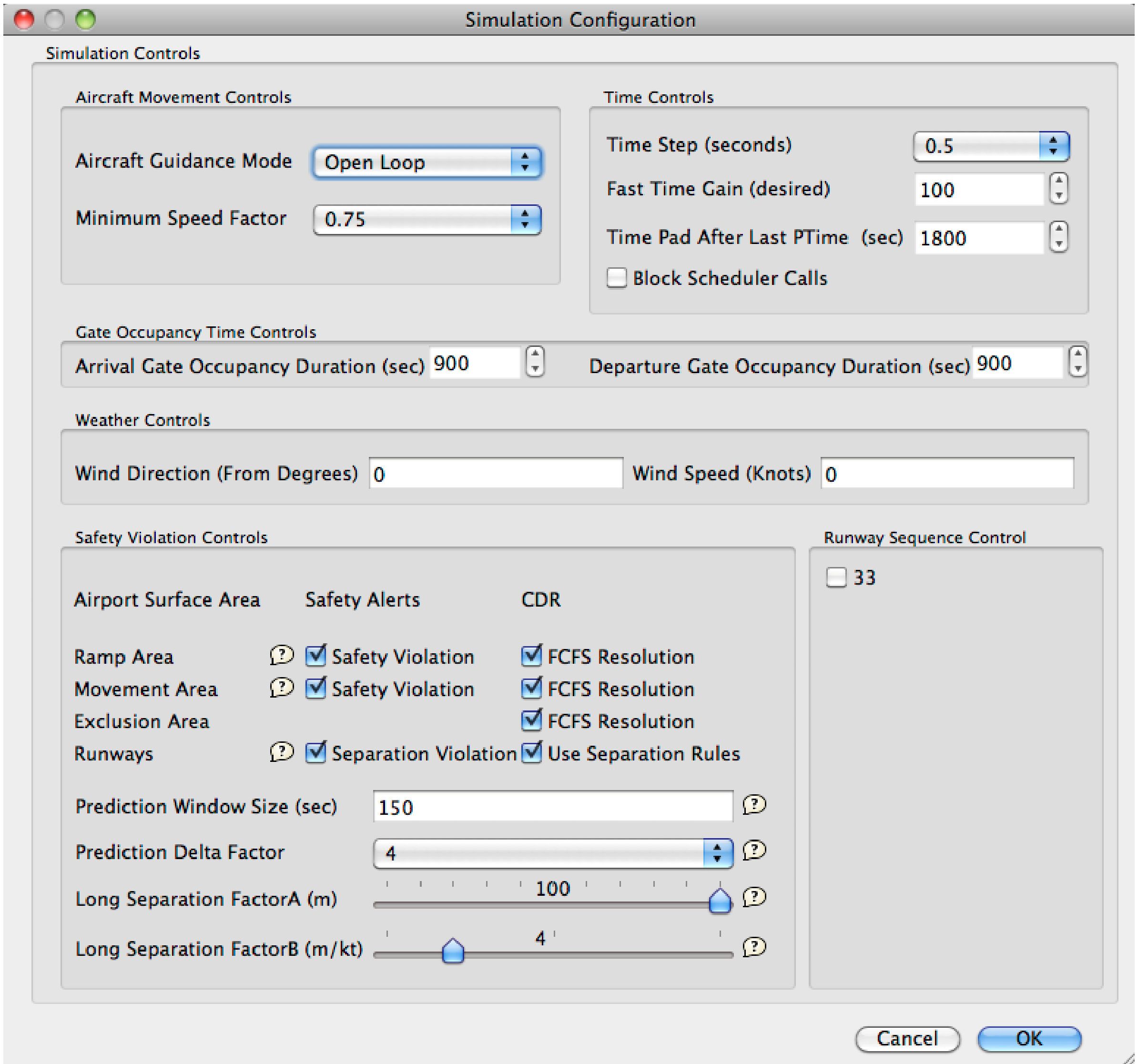


Figure 12

- Aircraft Guidance Mode – Open Loop or Close Loop
  - In Open Loop mode, SOSS moves aircraft using a command speed based on its nominal speeds.
  - In Close Loop mode, SOSS moves aircraft using a command speed within a lower and upper bound about its nominal speed. The upper bound speed is 120% of the nominal speed, and the lower bound is controlled by a Minimum Speed Factor (default is %75).
- Minimum Speed Factor – see above Close Loop Mode
- Time Step in seconds – this is the simulation delta time. Default is 0.5 seconds.

- Fast Time Gain – this is the desired fast time gain to control the speed of the fast time simulation. E.g., a 20 gain will finish simulation of 3600 seconds in about 180 clock seconds (per hardware).
- Time Pad after Last PTime – this is the amount of time in minutes added to the last PTime of all aircraft such that simulation will be forced to stop. In normal situations, simulation will stop when all aircraft have reached their surface destination. This is to prevent simulation from running forever in case of gridlock. Default is 30 minutes.
- Arrival Gate Occupancy Duration – the amount of time, in minutes, that an arrival aircraft will remain on the surface after reaching the gate.
- Departure Gate Occupancy Duration – the amount of time, in minutes, that a departure aircraft will be at gate before scheduled push back (PTime).
- Wind Direction – airport wind direction in true north, in degrees ("winds from") – used by landing and take off models
- Wind Speed – airport wind speed, in knots – used by landing and take off models
- A matrix of checkboxes is available to enable Safety Alerts and Conflict Detection and Resolution (CDR) in various airport surface areas. Rows represent specific surface areas while columns represent Safety Alerts and CDR functionality and are as follows:
- Safety Alerts enable violation detection, logging, and GUI visualization in three airport areas. When on, SOSS will show aircraft with violation with a distinct color and a flashing circle around the aircraft. A violation will also be logged and can be later exported to a file or viewed using one of several specialized widgets.
    - Ramp Area – physical separation violation between gate and spot.
    - Movement Area – physical separation violation between spot and runway.
    - Runways – violation of runway separation rules at runway crossings and departure nodes.
- CDR checkbox controls enable violation resolution in three airport areas
    - Ramp Area – conflict detection and resolution using FCFS between gate and spot.
    - Movement Area – conflict detection and resolution using FCFS between spot and runway.
    - Exclusion Area – conflict resolution using FCFS and arrival-on-landing priority that allows only one aircraft in a user defined geometric area
    - Runways – enforcement of user-specified runway separation rules for aircraft taking off or crossing a runway.
- Prediction Window Size is the look-ahead window in seconds used in safety violation prediction.

- Prediction Delta Factor is the multiple of simulation time steps that the prediction algorithm uses to predict aircraft positions in equal times. E.g., a value of 2 for 0.5 second simulation time steps makes the prediction delta time one second.
- Long Separation FactorA is the distance in meters that defines the minimal separation threshold requirement between aircraft. For instance a value of 0 would indicate the user preference to allow the nose of one aircraft to almost touch the tail of the other. The recommended setting is 10 to avoid “fender benders” in certain queue situations.
- Long Separation FactorB controls a dynamic distance buffer that uses a product of itself and the speed of an aircraft for additional separation requirement in head-to-tail situations. Thus when an aircraft A tailgates B the required separation threshold between them used by CD&R will be: Long Separtion FactorA + max(speed of A, speed of B) x Long SepartionFactorB. This is an important setting to prevent “pile on” violations when a leading aircraft is forced to suddenly stop (especially when its model allows for faster deceleration than the aircraft in the back). The recommended setting is 5.
- Block Scheduler Calls – if checked, SOSS will call scheduler(s) in blocking mode.
- Runway Sequence Control – it allows selection of runways to enforce aircraft runway access (departure and cross) sequence derived from runway usage times give by scheduler(s).

2.7 Traffic Management Interface Control

SOSS design has two types of traffic management control configuration. Choose menu ***Configuration | TMI | EDCT*** to set the Expected Delay Clearance Time for departure aircraft. Choose ***Configuration | TMI | Dept Fix Range*** for Departure Fix Separation Control.

2.7.1 Estimated Departure Clearance Time (EDCT)

Not implemented yet.

2.7.2 Departure Fix Separation Control (MIT)

Choose Edit | TMI | Departure Fix MIT to open the dialog:

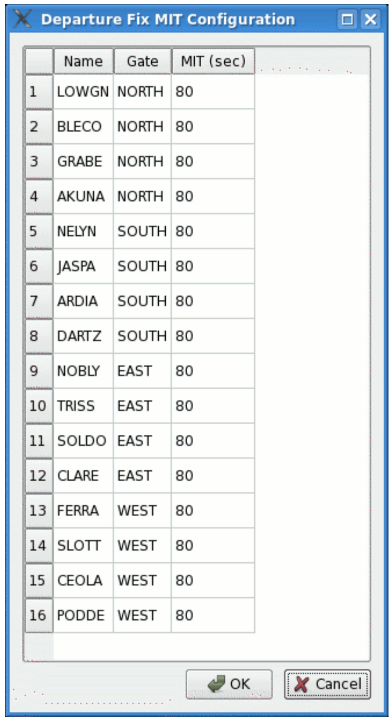


Figure 13

The dialog shows a table of all departure fix and their MIT in seconds. User can change the MIT values.

Click ***OK*** button to accept the configuration, or ***Cancel*** to cancel it.

2.8 Uncertainty Control

Figure 14 shows the configuration dialog window that user can configure uncertainties during the simulation.

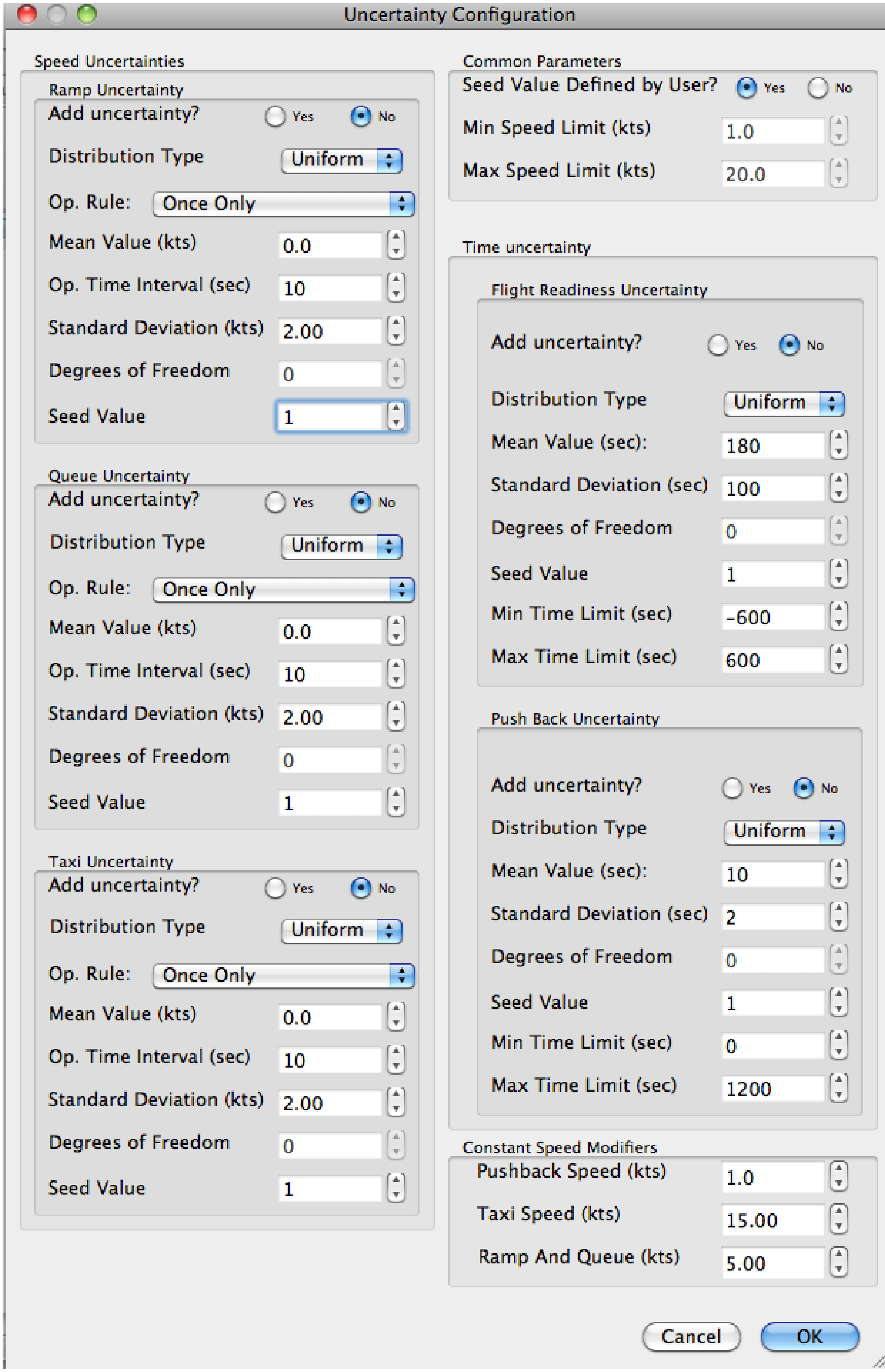

Uncertainty Configuration
Speed Uncertainties
Ramp Uncertainty
Add uncertainty? Yes No
Distribution Type Uniform
Op. Rule: Once Only
Mean Value (kts) 0.0
Op. Time Interval (sec) 10
Standard Deviation (kts) 2.00
Degrees of Freedom 0
Seed Value 1
Queue Uncertainty
Add uncertainty? Yes No
Distribution Type Uniform
Op. Rule: Once Only
Mean Value (kts) 0.0
Op. Time Interval (sec) 10
Standard Deviation (kts) 2.00
Degrees of Freedom 0
Seed Value 1
Taxi Uncertainty
Add uncertainty? Yes No
Distribution Type Uniform
Op. Rule: Once Only
Mean Value (kts) 0.0
Op. Time Interval (sec) 10
Standard Deviation (kts) 2.00
Degrees of Freedom 0
Seed Value 1
Common Parameters
Seed Value Defined by User? Yes No
Min Speed Limit (kts) 1.0
Max Speed Limit (kts) 20.0
Time uncertainty
Flight Readiness Uncertainty
Add uncertainty? Yes No
Distribution Type Uniform
Mean Value (sec): 180
Standard Deviation (sec) 100
Degrees of Freedom 0
Seed Value 1
Min Time Limit (sec) -600
Max Time Limit (sec) 600
Push Back Uncertainty
Add uncertainty? Yes No
Distribution Type Uniform
Mean Value (sec): 10
Standard Deviation (sec) 2
Degrees of Freedom 0
Seed Value 1
Min Time Limit (sec) 0
Max Time Limit (sec) 1200
Constant Speed Modifiers
Pushback Speed (kts) 1.0
Taxi Speed (kts) 15.00
Ramp And Queue (kts) 5.00
Cancel
OK

Figure 14

There are two types of uncertainties. One is aircraft speed uncertainty that affects aircraft nominal speed in each movement area. The other is delay uncertainty affects aircraft push back process.

2.8.1 Speed Uncertainty

There are three speed uncertainties for ramp, taxi and queue areas, respectively. The uncertainty is represented by a random variable value to be added to aircraft's nominal speed. For instance, if an aircraft's taxi area nominal speed is 14 knots, Operation Rule is set at Once, and a random number of 2 knots is generated for the taxi area uncertainty, then the aircraft will move at a target speed of 16 knots in taxi area.

Each uncertainty has the following configurable selections.

- Add uncertainty – to switch on or off the uncertainty (default is No)
- Distribution type – Uniform, Normal, Gamma, and Cauchy
- Operation rule – how often the random variable gets generated/re-generated for each aircraft
    - Once Only – SOSS generates a single uncertainty random value for an aircraft at the beginning of a simulation. The target speed of the aircraft will stay the same during the simulation
    - Every Simulation Iteration – SOSS generates a new uncertainty random value for an aircraft every simulation time step. The target speed of the aircraft will change quickest during simulation.
    - Every Several Seconds – SOSS generates a new uncertainty random value for an aircraft every constant period of time, set by the user. The target speed of the aircraft will change regularly during the simulation.
    - Every time AC accelerates – SOSS generates a new uncertainty random value when an aircraft starts to accelerate from stop.
- Standard deviation – standard deviation of distribution
- Seed value – user selected random sequence seed value

The default mean values of the speed random variable are all zero.

There is a global lower bound and upper bound that user can set on the configuration with the minimum and maximum speed limits. They are global settings and apply to all aircraft and all surface areas. They effectively truncate the uncertainty distribution within the bounds. In the previous example, if a maximum 15 knots speed limit is set, then the target speed will be truncated to 15 knots rather than 16 knots.

2.8.2 Time Uncertainty

There are two time uncertainties. They are related to departure aircraft push back process only.

The first one is called Flight Readiness Uncertainty. It adds an extra random delay for an aircraft to start push back from the gate. For instance, if an aircraft is scheduled to start push back at PTime =

100, and Flight Readiness Uncertainty causes an extra 10 second delay, then the aircraft will start push back (leaving the gate node) at time = 110 during simulation. Note that a scheduler may request departure gate holding. Using the previous example, if a scheduler requests the aircraft hold at the gate until time = 120, then the aircraft will start push back at that time; if scheduler's gate holding time = 105, the aircraft will start push back at time = 110. In other words, the aircraft will its gate at maximum of PTime + Flight Readiness Uncertainty and scheduler holding time (STR).

The second one is Push Back Uncertainty. The push back process is defined on the first link (from gate). The effect of this uncertainty is on the push back speed and ultimately the time the aircraft arriving at the end of the first link. In this case, a nominal push back time is calculated from the aircraft's nominal push back speed and the length of the link. Then a random amount of time from the Push Back Uncertainty is added to the nominal push back time. Finally, the effective push back speed is calculated as the link length divided by the total time. As a result, the aircraft will arrive at the end of the link with the uncertainty delay.

Like speed uncertainties, these two delay uncertainties parameters can be configured at the dialog window. The operation rule for the two uncertainties is always Once Only.

2.8.3 Constant Speed Modifiers

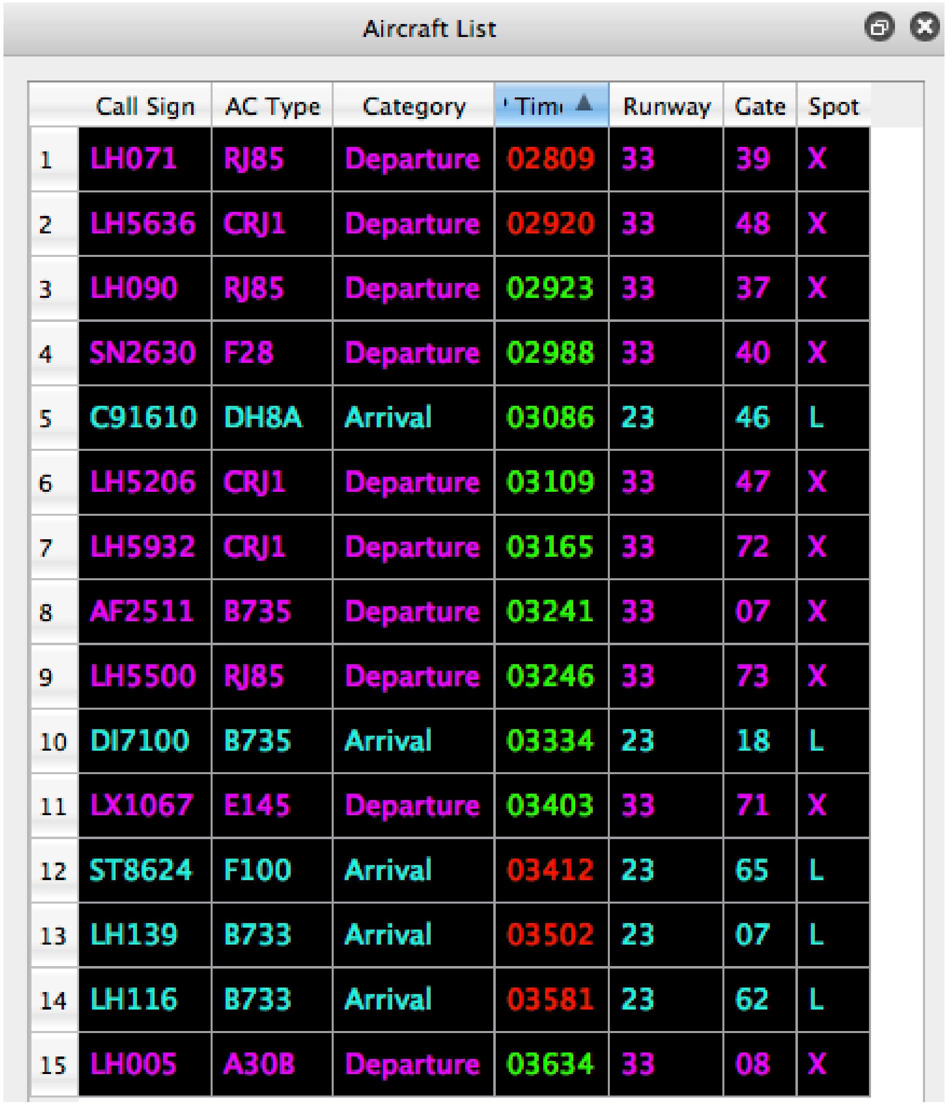
These controls allow the user to adjust nominal aircraft speed for pushback, Taxi, Ramp, and Queue areas. These are constant, rather than random, values and will be added to the existing nominal speed values.

2.9 Run Simulation

Once scenario data is loaded and configuration is done, simulation can be started, paused, and stopped by clicking the Start, Pause, and Stop tool buttons at the tool bar.

2.10 Aircraft List

Choose ***View | Aircraft List*** to view the aircraft list in a pop up dialog. Each aircraft shows its CallSign, Aircraft Type, Category, Spot Name, Runway, Gate Name. The font color in all columns but "P Time" corresponds to the values selected by user for arrival and departure aircraft icons from "Preferences". The background color of all cells is the same value as selected by user for airport background. The P Time column font is green if the aircraft is active, and red otherwise. Initially, the dialog is shown in a float window.



Aircraft List

	Call Sign	AC Type	Category	' Tim ▲	Runway	Gate	Spot
1	LH071	RJ85	Departure	02809	33	39	X
2	LH5636	CRJ1	Departure	02920	33	48	X
3	LH090	RJ85	Departure	02923	33	37	X
4	SN2630	F28	Departure	02988	33	40	X
5	C91610	DH8A	Arrival	03086	23	46	L
6	LH5206	CRJ1	Departure	03109	33	47	X
7	LH5932	CRJ1	Departure	03165	33	72	X
8	AF2511	B735	Departure	03241	33	07	X
9	LH5500	RJ85	Departure	03246	33	73	X
10	DI7100	B735	Arrival	03334	23	18	L
11	LX1067	E145	Departure	03403	33	71	X
12	ST8624	F100	Arrival	03412	23	65	L
13	LH139	B733	Arrival	03502	23	07	L
14	LH116	B733	Arrival	03581	23	62	L
15	LH005	A30B	Departure	03634	33	08	X

Figure 15

User can drag and drop the window to the main display area to dock the dialog:

Figure 16

2.11 View Check Boxes

From View menu, user can select and deselect viewing options.

Choose View | Show Node Link to toggle display of airport node-link model. This option is on by default.

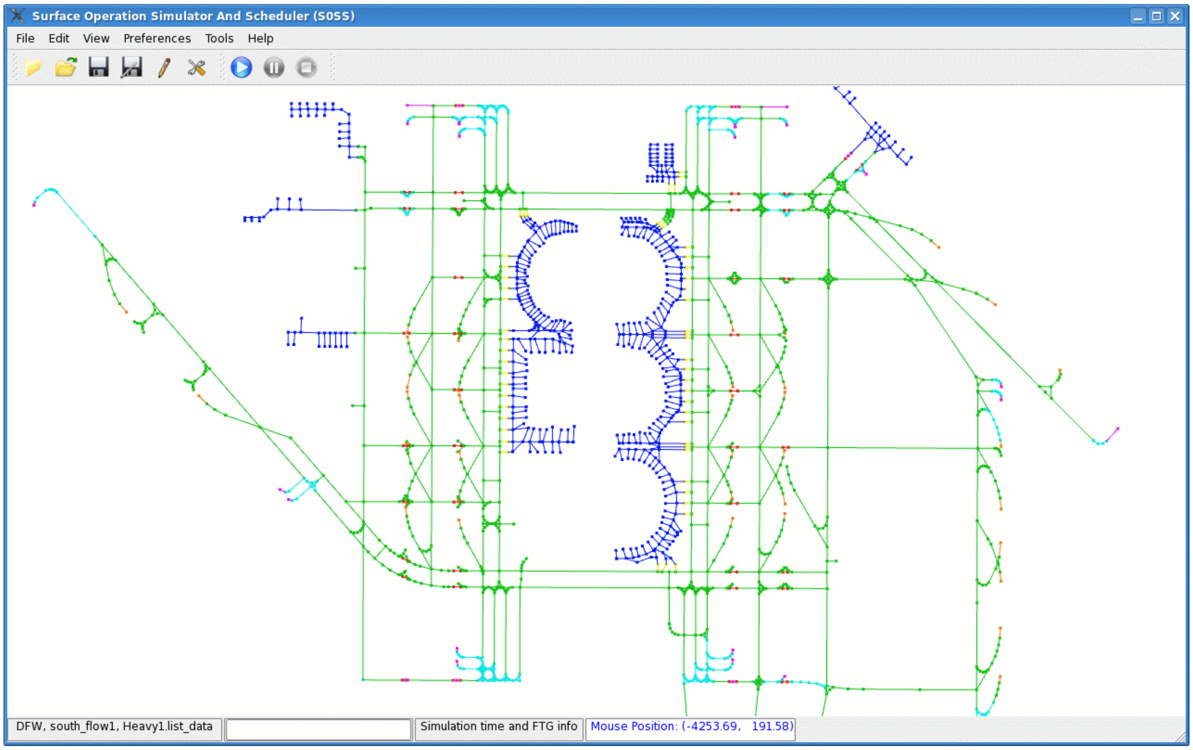


Figure 17

Choose View | Show Airport Map to toggle display of airport background map.

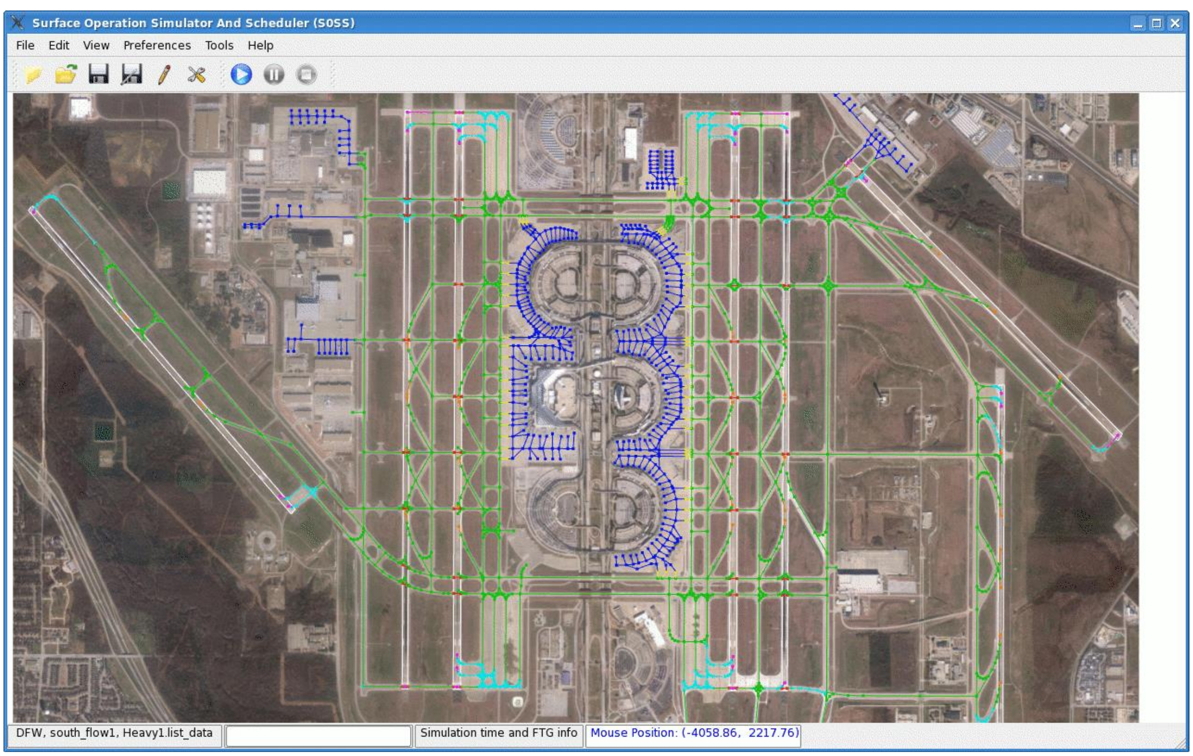


Figure 18

Choose ***View* | *Aircraft Callsign*** to turn on/off aircraft information block display in the map. The block currently has three numbers: aircraft call sign, aircraft type, and current speed in knots.

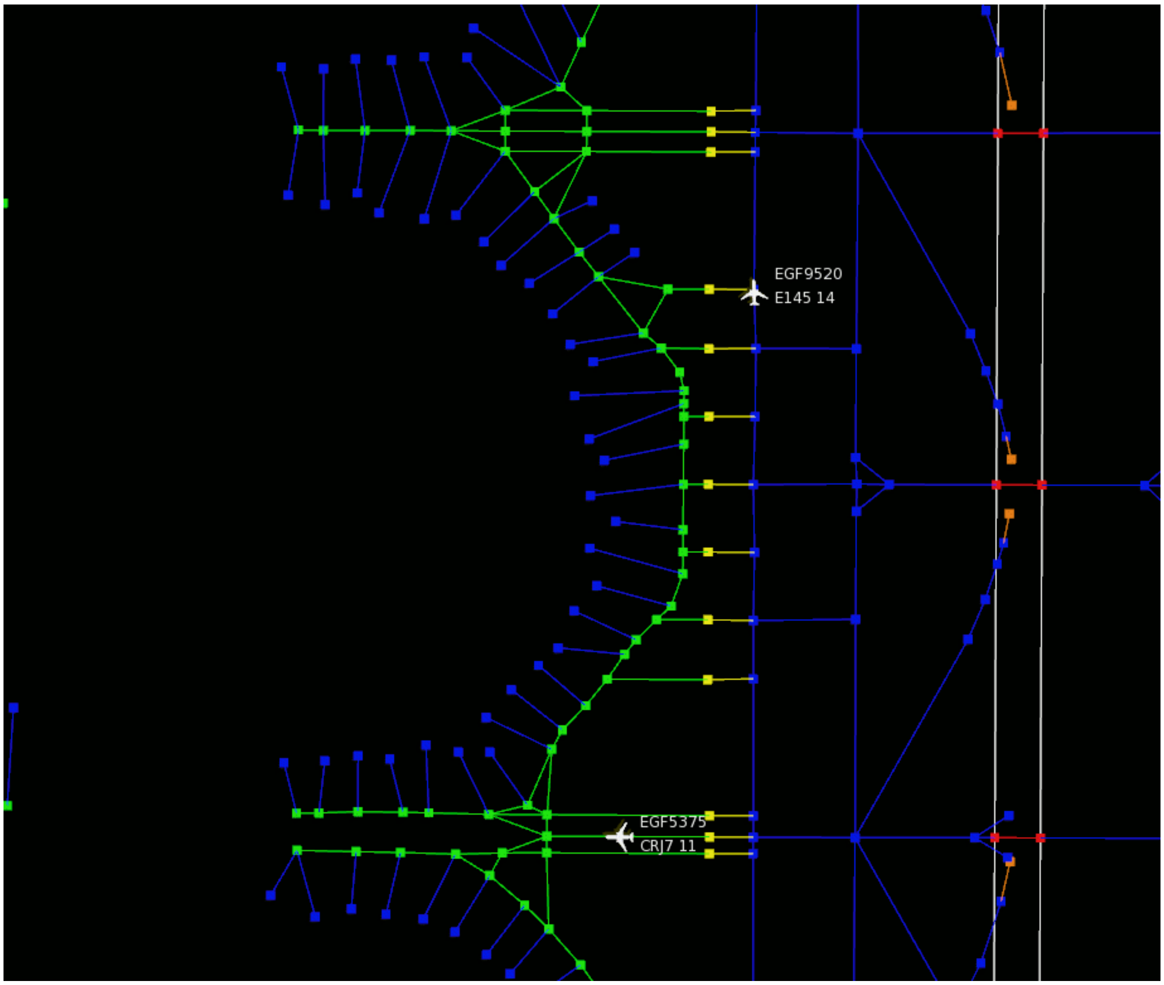


Figure 19

Choose ***View* | *Overlay*** to toggle display some runtime information on the map.

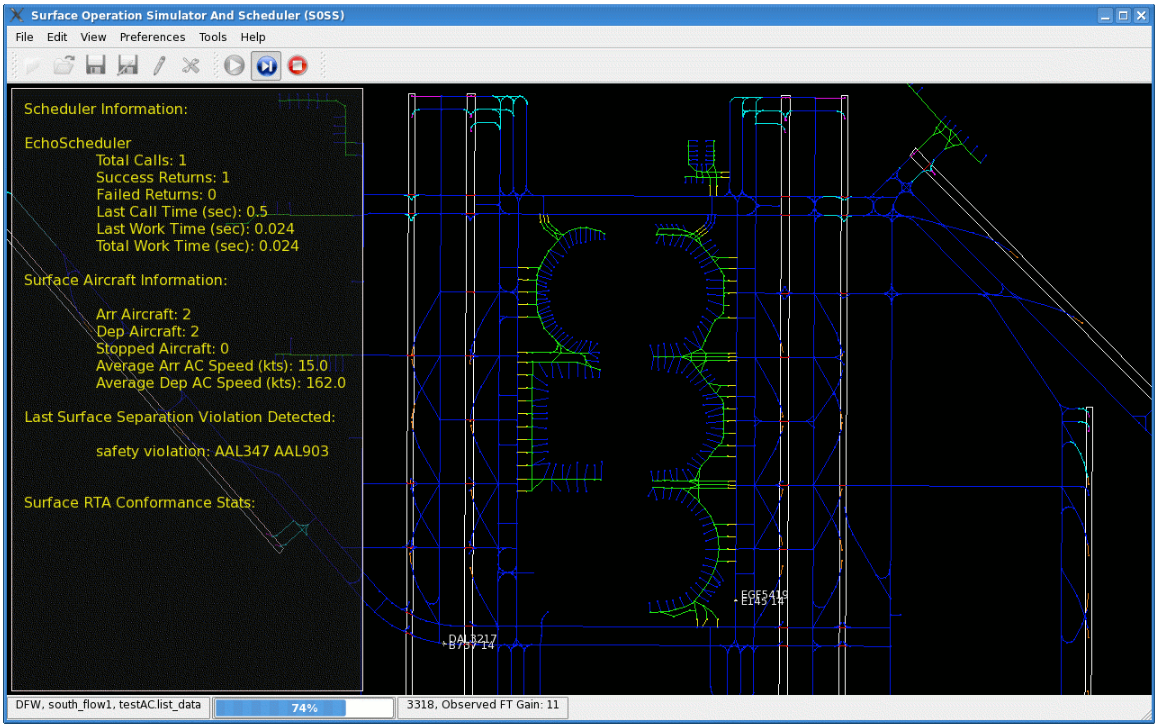


Figure 20

Choose ***View | Node Label*** and/***or View | Link Label*** toggles display of node and/or link labels. User needs to zoom in to see the labels. SOSS only display node and link labels in details to avoid map being crowded.

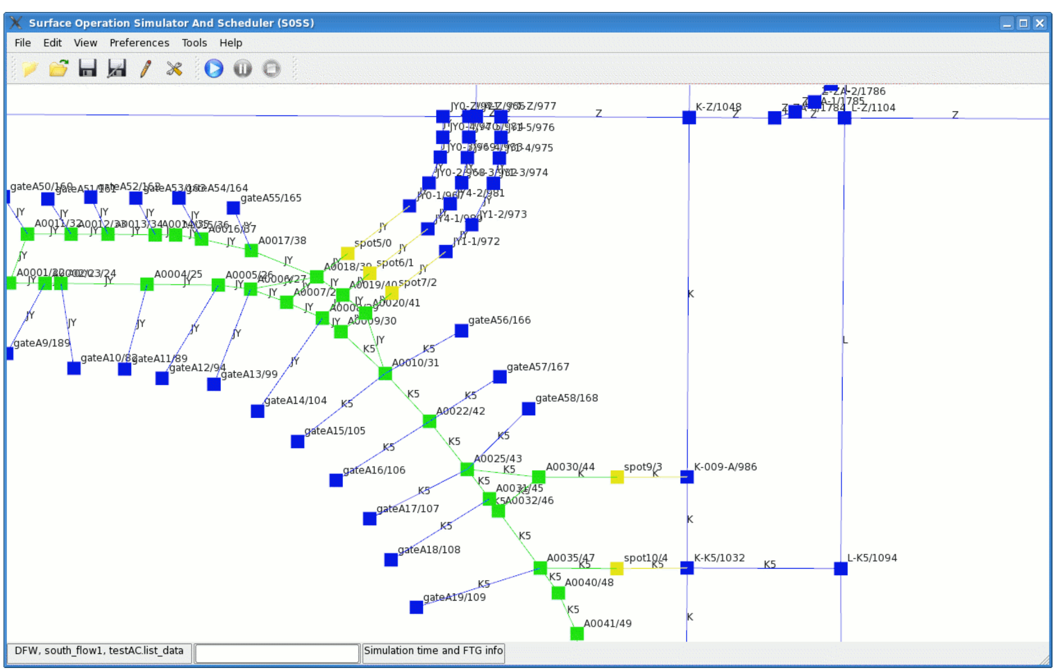


Figure 21

Choose View* | *Taxi Route to display the taxi route for the selected aircraft (from the Aircraft List). The taxi route is displayed for one aircraft only. User need select an aircraft from the Aircraft List.

A taxi route displays the route and three times at a node if it has received scheduled time. The three times are: scheduled time release (leaving from the node), actual time arrival, and actual time release.

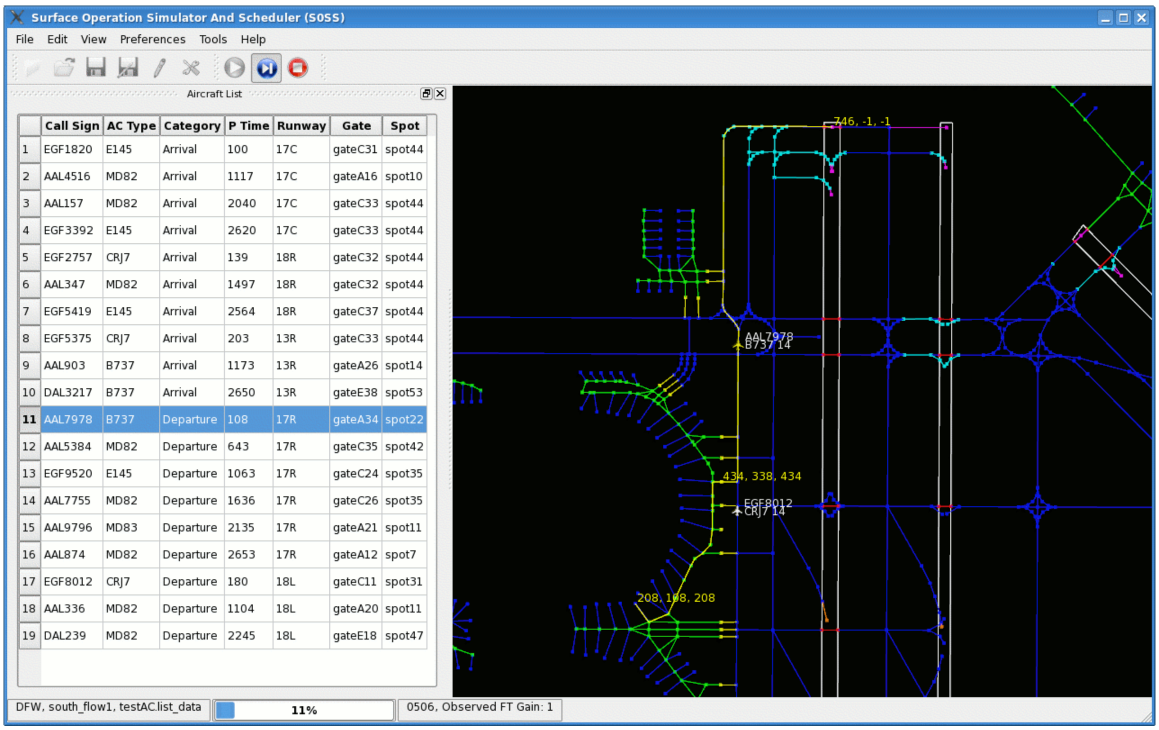


Figure 22

Choose View | Show CDR Dependency to display the action CDR is taking to resolve conflicts between aircraft. An arrow will originate from a yielding aircraft and point to one that has right of way. Red color arrow denotes head-on conflict resolution while yellow stands for tail-on conflicts.

2.12 Safety Violation Alert Display

When Safety Violation Alert is on, SOSS will show aircraft with violation with a distinct color and a flashing circle about the aircraft.

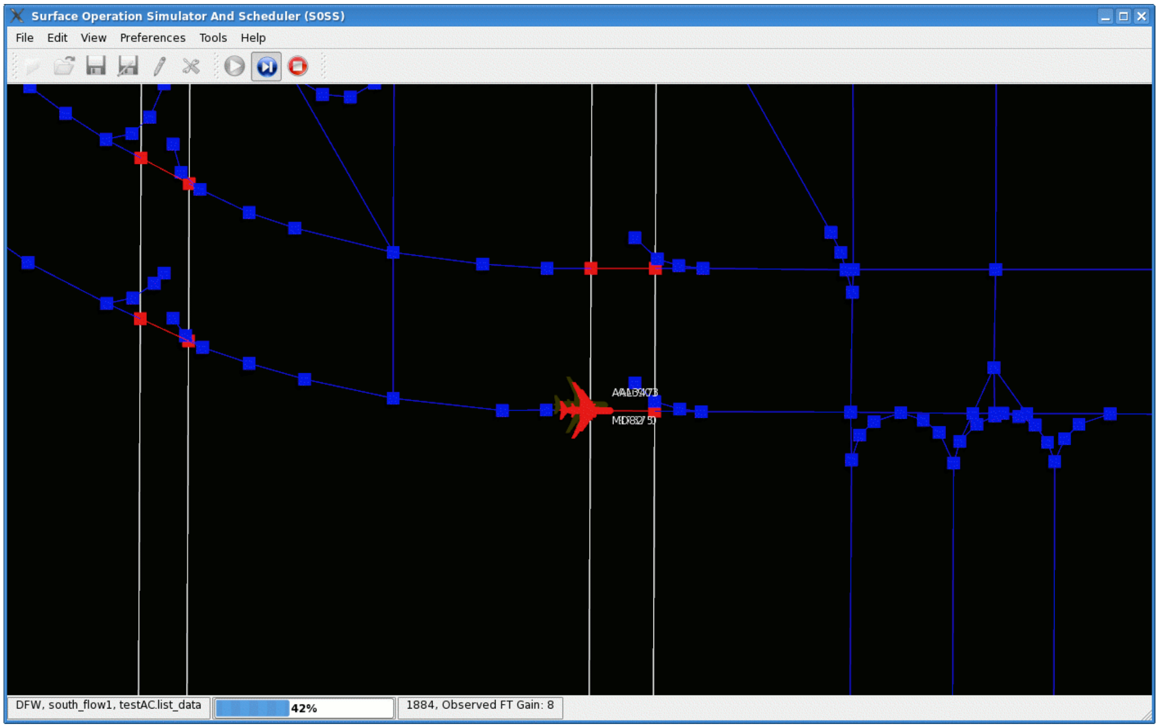


Figure 23

2.13 Mouse Controls

Current mouse controls allow pan and zoom in the airport display.

- Drag while holding right mouse pans the map
- Wheel up and down zooms the map

2.14 Tools

2.14.1 Plot AC Speed

After simulation has finished, this tool allows plot selected aircraft speed against time. User can use left mouse to create a rubber band on the graph to zoom in and click the zoom level button to zoom out.

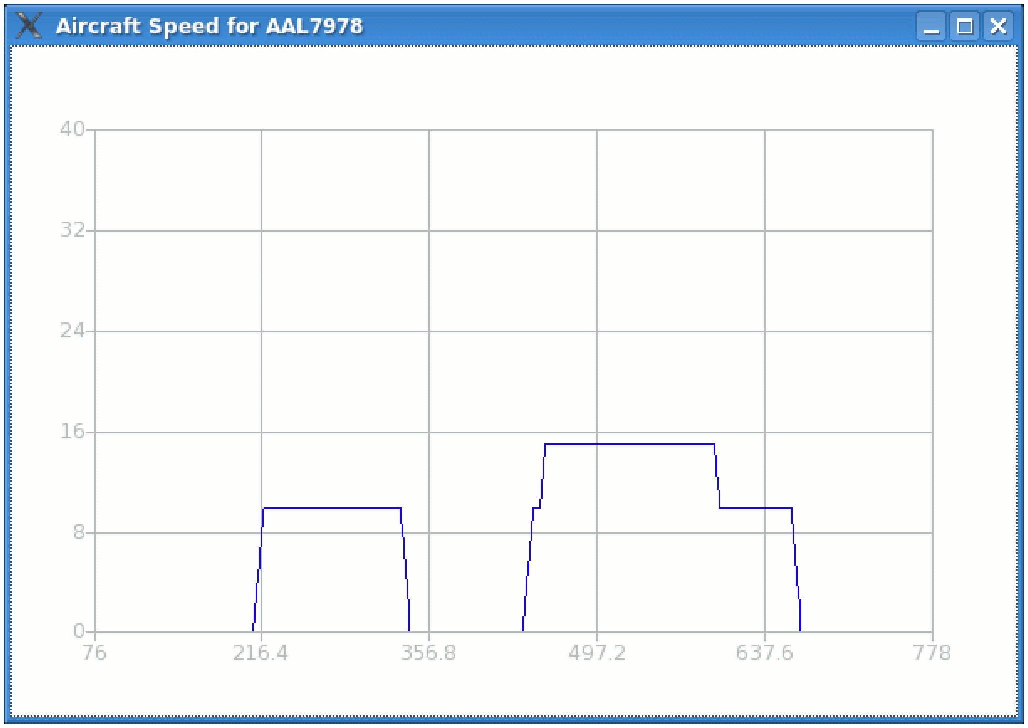
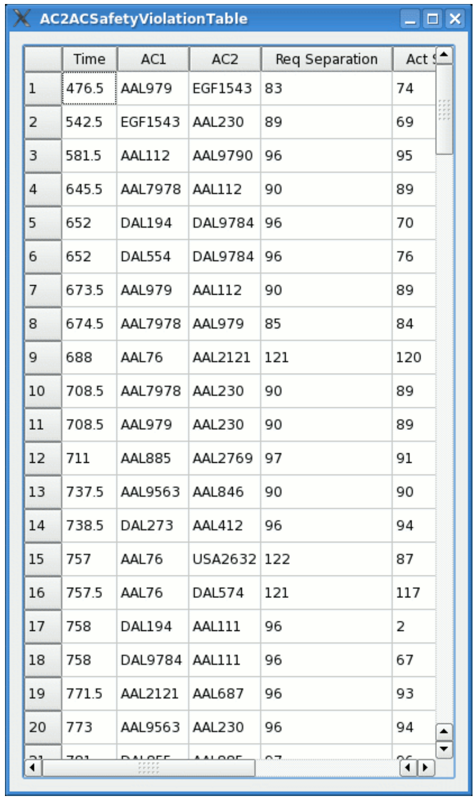


Figure 24

2.14.2 Show Aircraft to Aircraft Safety Violations

After simulation has finished, this tool displays safety violation alerts between two aircraft on surface between terminals and runways.

The violations are sorted with simulation time. Each row shows a safety separation violation between two aircraft that happened at first time. The aircraft call signs are shown in the columns following the time, followed by the required separation and actual separation in meters.



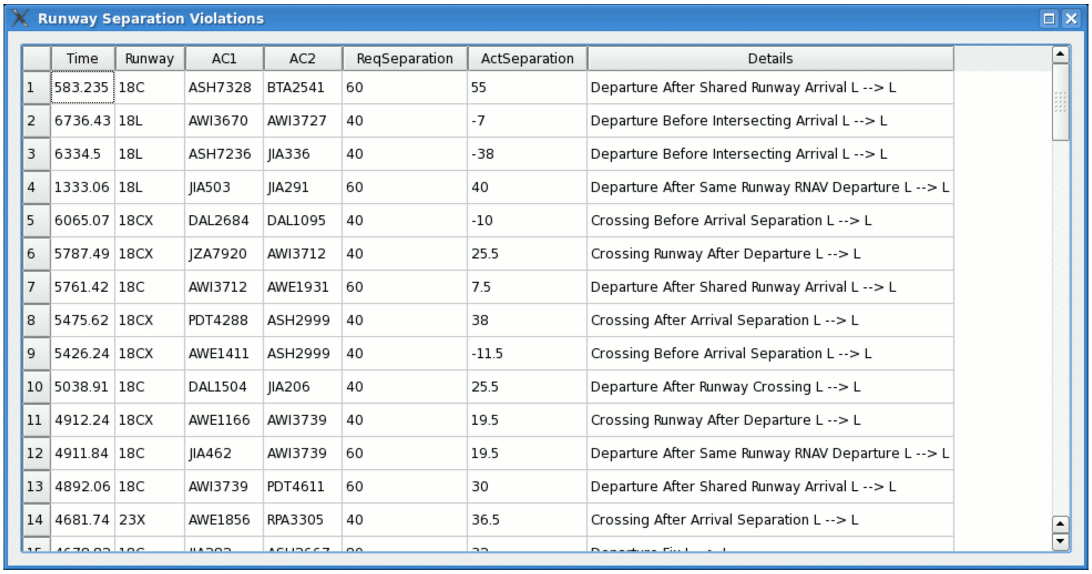
AC2ACSafetyViolationTable

	Time	AC1	AC2	Req Separation	Act S
1	476.5	AAL979	EGF1543	83	74
2	542.5	EGF1543	AAL230	89	69
3	581.5	AAL112	AAL9790	96	95
4	645.5	AAL7978	AAL112	90	89
5	652	DAL194	DAL9784	96	70
6	652	DAL554	DAL9784	96	76
7	673.5	AAL979	AAL112	90	89
8	674.5	AAL7978	AAL979	85	84
9	688	AAL76	AAL2121	121	120
10	708.5	AAL7978	AAL230	90	89
11	708.5	AAL979	AAL230	90	89
12	711	AAL885	AAL2769	97	91
13	737.5	AAL9563	AAL846	90	90
14	738.5	DAL273	AAL412	96	94
15	757	AAL76	USA2632	122	87
16	757.5	AAL76	DAL574	121	117
17	758	DAL194	AAL111	96	2
18	758	DAL9784	AAL111	96	67
19	771.5	AAL2121	AAL687	96	93
20	773	AAL9563	AAL230	96	94

Figure 25

2.14.3 Show Runway Safety Violation Display

Runway safety separation violations are between two aircraft when accessing runways. Each occurrence is recorded at the time the first happens. Runway separation is measured in time (of seconds). A runway separation rule requires safety separation in a same runway or a coupled runway operation. The runway shown in the display is the runway the second aircraft (AC2) access that caused a runway separation violation due to the first aircraft (AC1) runway operation (the same or other runway). The required and actual separation columns are in seconds. The detail of the violation is given in the last column.



Runway Separation Violations

	Time	Runway	AC1	AC2	ReqSeparation	ActSeparation	Details
1	583.235	18C	ASH7328	BTA2541	60	55	Departure After Shared Runway Arrival L --> L
2	6736.43	18L	AWI3670	AWI3727	40	-7	Departure Before Intersecting Arrival L --> L
3	6334.5	18L	ASH7236	JIA336	40	-38	Departure Before Intersecting Arrival L --> L
4	1333.06	18L	JIA503	JIA291	60	40	Departure After Same Runway RNAV Departure L --> L
5	6065.07	18CX	DAL2684	DAL1095	40	-10	Crossing Before Arrival Separation L --> L
6	5787.49	18CX	JZA7920	AWI3712	40	25.5	Crossing Runway After Departure L --> L
7	5761.42	18C	AWI3712	AWE1931	60	7.5	Departure After Shared Runway Arrival L --> L
8	5475.62	18CX	PDT4288	ASH2999	40	38	Crossing After Arrival Separation L --> L
9	5426.24	18CX	AWE1411	ASH2999	40	-11.5	Crossing Before Arrival Separation L --> L
10	5038.91	18C	DAL1504	JIA206	40	25.5	Departure After Runway Crossing L --> L
11	4912.24	18CX	AWE1166	AWI3739	40	19.5	Crossing Runway After Departure L --> L
12	4911.84	18C	JIA462	AWI3739	60	19.5	Departure After Same Runway RNAV Departure L --> L
13	4892.06	18C	AWI3739	PDT4611	60	30	Departure After Shared Runway Arrival L --> L
14	4681.74	23X	AWE1856	RPA3305	40	36.5	Crossing After Arrival Separation L --> L

Figure 26

2.14.4 Show Delays

TBD

2.14.5 Show AC Route Times

This tool displays, for a selected aircraft, the times along taxi route. A '-1' is used in place that no data is available. Furthermore, user can highlight any one particular table row, which will highlight the corresponding node on airport surface with a yellow square.

Aircraft Route Information DAL3027

	Node ID	Node Type	Nominal Time	Arrival Time	Release Time	Scheduled Release Time	Delay
1	149	ARRIVAL_NODE	312	312	312	-1	0
2	150	TAXI_NODE	317	316	316	-1	0
3	151	TAXI_NODE	321	320	320	-1	0
4	152	TAXI_NODE	326	326	326	-1	0
5	153	TAXI_NODE	357	357	357	-1	0
6	157	QUEUE_NODE	419	418	418	-1	0
7	158	QUEUE_NODE	422	422	422	-1	0
8	172	QUEUE_NODE	429	428	428	-1	0
9	175	QUEUE_NODE	434	434	434	-1	0
10	176	TAXI_NODE	484	484	484	-1	0
11	359	TAXI_NODE	501	501	501	-1	0
12	182	TAXI_NODE	508	508	508	-1	0
13	183	TAXI_NODE	517	516	516	-1	0
14	184	TAXI_NODE	526	525	525	-1	0
15	185	TAXI_NODE	534	534	534	-1	0
16	186	TAXI_NODE	543	543	543	-1	0
17	1555	RUNWAY_XING_NODE	547	547	547	-1	0
18	1556	RUNWAY_XING_NODE	553	552	552	-1	0
19	193	TAXI_NODE	554	554	554	-1	0
20	194	TAXI_NODE	559	559	559	-1	0

Figure 27

2.14.6 Show Scheduler Call History

TBD

2.14.7 Show Runway Usage History

Runway Usage History shows runway use times sorted by runway and then times. Two runway uses are included: runway departure and runway crossing, distinguished by Use Type column.

Runway departure rows have departure Fix ID and runway-crossing rows have crossing name

Runway Usage History

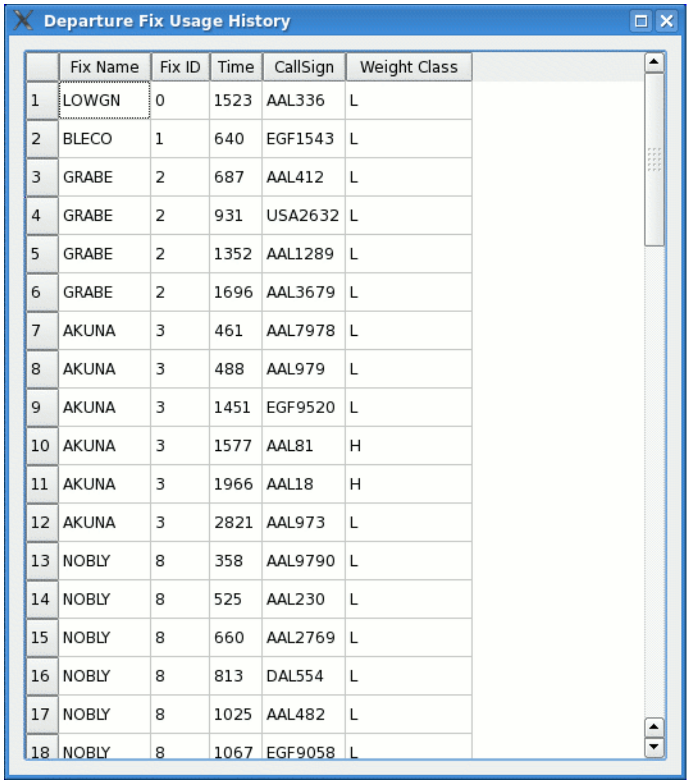
	Runway	Time	CallSign	Weight Class	Use Type	Fix ID / Cross Name
19	18C	2752	N676PC	L	Dept	0
20	18C	2812	JIA207	L	Dept	2
21	18C	2872	PDT4168	L	Dept	0
22	18C	2932	JIA388	L	Dept	1
23	18C	3012	JIA331	L	Dept	1
24	18C	3072	ASH2681	L	Dept	4
25	18C	3132	BTA2969	L	Dept	1
26	18C	3192	AWE1539	L	Dept	4
27	18C	3232	JIA276	L	Xing	856_857
28	18C	3272	AWI3556b	L	Dept	0
29	18C	3342	AWI3556a	L	Xing	856_857
30	18C	3382	AWE807	H	Dept	2
31	18C	3442	AWE1297	L	Dept	3
32	18C	3482	RPA3266	L	Xing	856_857
33	18C	3522	AWE996	L	Dept	1
34	18C	3602	ASH2608	L	Dept	1
35	18C	3642	AWE1087	L	Xing	856_857

Figure 28

2.14.8 Show Departure Fix History

The departure fix usage table shows the departure fix being used by aircraft information. It has five columns:

- Departure Fix (name)
- Departure Fix (Id)
- Time (of departure fix) – this is the time a departure aircraft starting taking-off
- Call Sign (of the aircraft)
- Weight Class (of the aircraft)


Departure Fix Usage History

	Fix Name	Fix ID	Time	CallSign	Weight Class
1	LOWGN	0	1523	AAL336	L
2	BLECO	1	640	EGF1543	L
3	GRABE	2	687	AAL412	L
4	GRABE	2	931	USA2632	L
5	GRABE	2	1352	AAL1289	L
6	GRABE	2	1696	AAL3679	L
7	AKUNA	3	461	AAL7978	L
8	AKUNA	3	488	AAL979	L
9	AKUNA	3	1451	EGF9520	L
10	AKUNA	3	1577	AAL81	H
11	AKUNA	3	1966	AAL18	H
12	AKUNA	3	2821	AAL973	L
13	NOBLY	8	358	AAL9790	L
14	NOBLY	8	525	AAL230	L
15	NOBLY	8	660	AAL2769	L
16	NOBLY	8	813	DAL554	L
17	NOBLY	8	1025	AAL482	L
18	NOBLY	8	1067	EGF9058	L

Figure 29

2.14.9 Zoom to Node/Link

This tool allows user to zoom to a node or link. Only node/link index is supported.

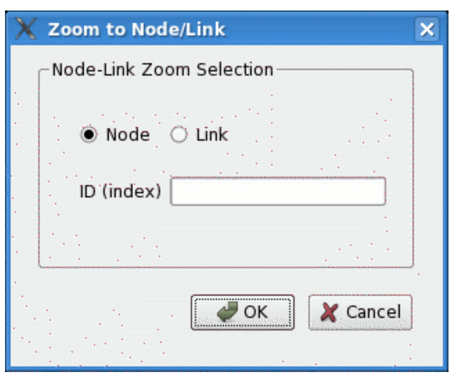


Figure 30

2.15 CDR Dependency

Choose View | Show CDR Dependency to view CDR interaction between conflicting aircraft. If CDR is enabled and active this tool will show the resolution implemented by the CDR

module for every conflicting pair. An arrow pointing from a yielding aircraft to the one with right of way visualizes the resolution. The color of the arrow is a key to conflict type, where red denotes head-on conflict while yellow corresponds to tail-on.

2.16 Playback Mode

Playback mode allows user to replay and closely examine a previously ran scenario through a variety of features.

2.16.1 Switching Mode

Switching between Simulation and Playback modes is achieved through a drop down "Mode" menu one can find among the top menu bar items of SOSS GUI. Switching modes can only be achieved when SOSS is not running in either mode. In other words you have to stop playback or simulation in order to enter a different mode.

2.16.2 Playback Overview

The playback database may contain only partial simulation data, depending on how far the original simulation has ran its course. Thus even a partial 10 second sim run can be stored and/or replayed in this mode.

The user may change the direction or speed without pausing or stopping the playback.

A freshly loaded playback will start at t = 0 in forward play or at t=scenario_length in reverse play.

If there is no playback data for a particular time step in a partial playback database the aircraft will either stay at their last know location or will not be displayed at all, depending on the direction of playback.

Playback configuration file that is stored along with the database points to the original scenario, aircraft, and airport data. This data must be present during playback in order for many GUI tools to work, such as displaying of aircraft routes, airport surface map, etc.

SOSS stores the its previous GUI mode along with scenario/playback data. When restarted it will returned to the same mode it was at closing time as well as load the original scenario/playback database. Note that for the second use case when a playback database was not stored it will revert to last known binary playback database.

2.16.3 Playback Database

The database is an sqlite3 DB in binary format with an extension *.playdb and contains aircraft state information that allows SOSS to display AC position during playback. It currently does not contain any CDR data. Along with the database a copy of a configuration file is saved under the same root name but with a *.txt extension.

2.16.4 Playback Controls

In Playback a toolbar specific to this mode will appear at the top of the main SOSS GUI window as seen in Figure 31.

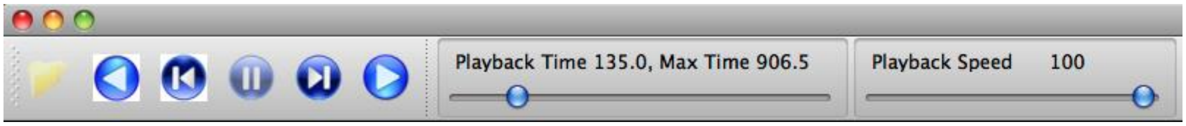


Figure 31

- Open Playback database – open a previously saved database
- Forward and Reverse Play buttons allow changed the direction of playback
- Forward and Reverse Step/Pause button allow the user to pause and advance playback time in single simulation step increments in either direction
- Pause button
- Playback Time slider allow the user to advance to particular playback time. This control is interactive, updating playback simulation snapshot depending on slider position.
- Playback speed slider allows the user to change the speed of playback

2.17 Save Simulation Data

Almost all simulation data are kept in an internal (in memory) database. They can be selectively saved to text files with the Save Simulation Data To File option under the File Menu. The database itself can also be dumped to an external database file for late retrieval (e.g., for playback).

2.17.1 Save Simulation to Data Files

After simulation has finished, ***select File | Save Simulation Data to Files*** allows user to select a directory to save following data results. All data files are in plain text format with header information.

- ACStateHistoryData.txt – all aircraft dynamic information at each simulation time step
- ACRTAConformance.txt – scheduled and actual times for each aircraft
- ACScheduleData.txt – aircraft times at each node of taxi route
- SchedulerExecution.txt – scheduler call history
- SchedulerStability.txt – scheduler requested times for each aircraft
- SafetyViolation.txt – safety violation information
- AirportScheduleData.txt – airport runway usage information
- Configuration.txt – simulation configuration data
- GUIPreferences.txt – gui preference data

2.17.2 Save Simulation to Database

After simulation has finished, ***select File | Save Database*** or ***Save Database As*** allows user to select a directory to save the whole internal database to a file that can be loaded back at a later time. This is useful for playback.

3 Command-line SOSS

SOSS can also be run using its command-line build, soss. To run SOSS command-line application, a SOSS configuration data file is needed as the input:

./soss configuration_data_file.

There is an example configuration included under the test directory.

The configuration file is in plain text format. It is advised to use SOSS GUI to configure the parameters and save it to a configuration data file.

4 Command-line Data Validation Tool

A SOSS input data check tool, dataValidate, is included to help verify the integrity of the input data to SOSS. It is a command-line executable that takes a scenario data file as the command- line argument. It is highly recommended to run this tool to check new scenario data and new airport adaptation files.

The tool has to be run in the bin directory of SOSS build to make sure it can access referenced airport and aircraft data files. For instance, to check a scenario data named MyScenario.list_data:

./dataValidate MyScenario.list_data

The dataValidate tool will:

- Parse the scenario data
- Load airport model and set runway configuration (specified in the scenario)
- Verify the loaded airport model (nodes, links, fixes, runways)
- Verify existence of static taxi routes for all flights
- Validate tail number dependency mapping for turnaround aircraft

If a SOSS exception (such as a runway node is not defined in the node data) is caught, dataValidate will stop and display an error message.

Some non-critical errors (such as a static taxi route cannot be found between a terminal and runway for a flight) are found during the process, dataValidate will display the error messages.

The tool also shows some information messages such as runway departure, arrival and crossing nodes.

5 Surface Conflict Detection and Resolution

For details of CD&R logic and data output, please refer to document 'SOSSCDRLogicDescription.pdf'

6 Runway Sequence Control (RSC)

"Runway use" for the purpose of RSC is defined as an act of traversing across a runway crossing or as taking off from a runway. Thus "runway use node" will be the first crossing node in case of the former, and the departure node for the later. Runway Sequence Control is a user-selected option that mandates every aircraft to satisfy its requirement before proceeding with runway use. This option can be selected independently for every runway and necessitates the use of a scheduler. When enabled, the RSC algorithm will compare the Scheduled Release Time (SRT) of the runway use node received from the scheduler for every aircraft that will use a controlled runway. The aircraft call signs will be entered into a queue and sorted in ascending order based on their respective SRTs. In the case when an aircraft was not issued an SRT for a runway use node by the scheduler it will be omitted from the queue. The scheduler can change aircraft's position in the queue by issuing a new SRT with every successive call. An aircraft is allowed to use the runway by RSC only if it occupies the front most position in the queue. For example when aircraft A tries to take off and aircraft B is trying to cross the same runway the right of way will be determined by the front position in the queue, regardless of which aircraft got to their respective runway use nodes first. Once the runway operation is completed the aircraft will be removed from the queue.

One of the reasons to enable RSC would be to prevent runway use starvation of one aircraft by others when it is at a disadvantage by imposed Runway Use Separation rules.

7 Critical Area Control

This feature is an addition to runways safety separation control. It allows the user to define a polygon by specifying the x,y coordinates of at least three vertices within CriticalArea.txt file. Thereafter if Critical Area control is enabled only one aircraft at a time will be allowed within this area at any given time. The aircraft will queued up on a first come first serve basis. This feature was designed and is particularly useful for preventing aircraft entering runway boundaries in multiple departure nodes per runway scenarios, like HAM. Using Critical Area Control an aircraft will not wait on the runway surface at one departure node while being "overrun" by another aircraft taking off from a departure node further up.

8 Dynamic Scenario Input (Beta)

New architecture allows SOSS to be a part of a distributed simulation environment. In the future aircraft data will be provided by a component unrelated to SOSS and added to the simulation at any time. (As opposed to all aircraft being loaded from a text file and known before simulation begins). Currently this capability is simulated by Scenario Manager that creates new aircraft objects only

within a specified forecast window of that aircraft's PTime. As soon as aircraft "lifespan" is exhausted within the simulation (departure has crossed a fix or arrival has reached its gate and finished disembarking) it will be removed and cleaned up from simulation. Current use of this feature include significantly increasing simulation performance for scenarios spanning a large time window and involving a large number of aircraft. To enable this mode, the user must enable Dynamic Simulation Input and specify absolute input scenario path within SOSS configuration file. See "Dynamic Scenario Input Controls (Beta)" withing configuration file for details.